# CARBON DIOXIDE SNOW

## ITS THERAPEUTIC USES.

J. HALL-EDWARDS.

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# CARBON DIOXIDE SNOW:

## ITS THERAPEUTIC USES

(METHODS OF COLLECTION AND APPLICATION).

BY

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# PREFACE.

*The general adoption of carbon dioxide snow as a reliable therapeutic agent has created an opening for the publication of a volume setting forth the methods of collecting, preparing, and applying it, in such a manner as to meet the requirements of the dermatologist and general practitioner.*

*It is with the object of trying to fulfil these requirements that I venture to offer to the profession this modest little book, which, whilst it can in no way be considered a complete treatise upon the subject, deals with it at sufficient length to answer its purpose. All reference to cases treated has been purposely omitted, so as to render it as concise as possible.*

*In addition to describing the results obtainable from the use of carbon dioxide snow as a therapeutic agent, it contains a* *description of special apparatus I have designed for collecting and applying it in an efficient manner. In the perfection of this apparatus I have been greatly helped by Messrs. Philip Harris and Co., Ltd., Edmund Street, Birmingham, to whom I beg here to tender my sincere thanks.*

JOHN HALL-EDWARDS.

141 *Great Charles Street,*
*Birmingham.*

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## INTRODUCTION.

HEAT has been used as a therapeutic agent through all ages, and has stood the test of time to such good purpose that even now it heads the list, and holds its own against all competitors. The latest developments of electro-therapeutics depend to a great extent upon its action, whilst our means of administering it to the best advantage are constantly being improved, and sought for. It is the most popular remedy known, and without being in the least degree pessimistic, I doubt if we shall ever find any therapeutic agent to replace it. Volumes have been written upon its therapeutic effects, and there is not a medical man on the register who has not prescribed it.

Of the effects of low temperatures we know little, and of extreme cold, until quite recently, we knew nothing. The introduction of liquid air opened up a new field for investigation, which was eagerly seized upon by experimenters, with the result that a new therapeutic agent of great usefulness was discovered. To Campebell White is ascribed the honour of first pointing out its usefulness, and the first surgeon in this country to read a paper and exhibit cases treated by it was the late Radcliffe Crocker.

Liquid air has never been a popular therapeutic agent, not because it does not produce good results, but on account of the difficulties experienced in obtaining and transporting it.

Air can be converted to the fluid state by the combined effects of pressure and extreme cold.

Long after liquid air was produced, and its properties known, it was unobtainable, for the reason that the necessary apparatus for manufacturing it was not produced commercially. The few machines in existence were private property, and were used only for producing it for experimental purposes. Hence, although many medical men from a knowledge of its properties predicted its usefulness, none were in a position to verify their predictions.

Even had it been obtainable, the difficulties of transporting and keeping it had yet to be overcome. To Sir James Dewar we owe the solution of the difficulty. He invented a vessel in which it could be carried about with a minimum of loss, but even now it can only be obtained at considerable trouble and expense, notwithstanding the fact that the necessary apparatus for producing it is on the market.

If liquid air is kept in open vessels, it evaporates with greater rapidity than does water boiling over a fire, and, in addition, the pressure of its vapour is so enormous that it would burst any vessel in which it could be enclosed. At ordinary temperatures no vessel can withstand this internal pressure, and experiments with it were impossible until the Dewar flask was devised.

There are three ways in which heat flows from one place to another—by conduction, when it passes from one part of a body to another, or from one body in contact with another; by convection, when air or water heated by contact with a hot body rises through the colder fluid around it, carrying heat with it; and by radiation, when heat passes directly from one body to another, as from the sun to the earth, without warming the intervening medium.

Taking these facts into consideration, Dewar devised a vessel which reduced the transference of heat to a minimum. His vessels consist of two glass walls with a space between them from which the air has been exhausted. A vessel thus made reduces the evaporation of the liquid air to one-fifth of the ordinary rate. To stop radiation it is necessary to have a polished surface, so the vessels are silvered on the inner wall. By this means he reduced the evaporation to a sixth part. The combined results thus reduce the loss by evaporation to the thirtieth part of that which takes place in an open vessel.

Although it has been predicted that ultimately liquid air will be produced at the cost of a few coppers a gallon, it can only now be obtained from a limited number of sources, and notwithstanding the advances made in its transportation, it is an exceedingly costly therapeutic agent.

Notwithstanding the difficulties which stood in the way of using liquid air as a therapeutic agent, its effects had been investigated by many prior to the suggestion that solid carbon dioxide should be used in its place. To Pusey, of America, is accorded the honour of first trying this remedy, and publishing the results obtained. Many others, both in America and in this country, repeated Pusey's experiments, with the result that to-day it has become a well-recognised method of treatment.

Freezing by means of liquid air and carbonic dioxide snow produce similar results which differ only in degree. The former produces a much lower temperature than the latter, whilst its cauterising properties are also more marked. It is an open question as to whether the degree of frost produced by carbon dioxide snow does not give it the advantage, but there can be no doubt that its ease of production, its portability, and the fact that it can always be kept in readiness for use, render it far superior as a therapeutic agent.

Carbon dioxide gas is easily and cheaply prepared by many methods well known to chemists. It is reduced to the fluid state by pumping it into steel cylinders, in which it is sold in large quantities to manufacturers of mineral waters. It can be obtained in every large town in nearly every country, and can be transported to the most distant parts of the world with perfect safety. As the pressure inside the cylinders increases with the temperature, they should be kept in as cool a place as possible. The fluid gas will keep for an almost unlimited time, and, granting that the stopcock is kept clean, is always ready for immediate use.

Numerous methods of collecting and compressing the snow have been described, of which I make no mention in this little book. Firstly, because some of them are distinctly wasteful, and, secondly, because the method herein advocated has stood the test of time in the hands of hundreds of medical men who have adopted it to their entire satisfaction. By means of its help a compressed tablet or cone possessing all the properties requisite for successful therapeutic treatment can be produced in a few minutes with a minimum of waste. It can be handled by anyone possessed with the smallest amount of technical skill, and is always ready for use.

# CARBON DIOXIDE SNOW:

## ITS THERAPEUTIC USES.

### THE ADVANTAGES OF TREATMENT BY CARBON DIOXIDE SNOW.

Of the many recently-introduced therapeutic agents, there are few, which in their usefulness and ease of application, have commanded more attention from the profession at large than has solid carbon dioxide. During the last three or four years it has firmly established itself as a most valuable addition to our list of physical therapeutic agents, and in the hands of the general practitioner and dermatologist, it has secured an amount of success which can only be compared with the results achieved from the use of radium and x-rays. On account of the readiness with which it can be obtained, the simplicity and ease of its application, and the perfection of its results, it has won for itself a well-deserved popularity. As a stimulating and cauterising agent, it is superior in some respects to radium, over which it has a distinct advantage, on account of the slight cost involved.

## THE EFFECTS OF FREEZING UPON THE TISSUES.

The effects of freezing upon the tissues vary with the time they are kept frozen, and with the intensity of the cold applied. Slight freezing, such as is used in the production of local anæsthesia, brings about only a temporary disturbance of function, which is quickly righted, and which leads to no permanent injury. Even with slight freezing with ether or ethyl chloride, much damage can be done if the process is seriously prolonged, and total destruction of the superficial tissues can be brought about. Freezing in this manner, however, is always of short duration, and, as a rule, is only resorted to in cases where a simple incision or any other short operation has to be undertaken. This method has also been used in the treatment of some skin diseases, and has been recommended for allaying the inflammation in cases of erysipelas.

Both extreme heat and extreme cold are used by surgeons to destroy redundant or diseased tissues, and although they both ultimately may bring about the same result, their action differs in certain and important respects to such a marked degree that there are always good and scientific reasons for preferring one modality to the other. Apart from great differences in their physiological action, the advantages of cold over heat are, firstly, that freezing is nearly painless, whilst the actual cautery is, perhaps, the most painful procedure known ; and, secondly, that whilst freezing has little or no effect upon the system generally, and its local action is limited to the area frozen, the actual —or galvano—cautery frequently produces severe constitutional disturbance, and the tissues are destroyed or seriously injured for a considerable area round the spot operated on.

## LIQUID AIR AS A THERAPEUTIC AGENT.

Until within the last few years, we had no method at our command for freezing the tissues which could be easily obtained, could be restricted in its action to the area chosen, and which, at the same time, could be applied with ease and certainty. Prior to the introduction of carbon dioxide snow by Allan Pusey, of Chicago, in 1908, liquid air had been used as a local destructive agent by dermatologists, especially in America. It was first used in this country by the late Radcliffe Crocker, who published details of a large number of cases which he had treated with excellent results.

The possibility of liquid air being useful to the surgeon early presented itself to the minds of many who were aware of its properties, but the difficulty of obtaining and transporting it stood in the way of its general use.

It has been used successfully in the treatment of warts, nævi and angiomata, also in cases of lupus vulgaris, chronic eczema and lichen planus. Up to quite recently there was the very greatest difficulty in obtaining liquid air, and even now that this has to an extent been overcome, we are still confronted with the difficulties of transportation and storing.

Owing to the great rapidity with which it evaporates, it can only be carried about in specially constructed vessels, which cannot be corked or stoppered, or they would burst from internal pressure. It can only be carried about in small quantities at a time, and cannot be kept ready to hand when its use may be required. The walls of the special vessels used are composed of two thicknesses of glass with a space between them from which the air has been exhausted, the inner walls are also silvered. These vessels are generally known as Dewar's flasks. Apart from this, the liquid is difficult to apply to small patches, and considerable skill and practice are necessary to limit its effects to the areas requiring treatment. It produces an intense cold, reaching as low as 120 degrees centigrade below zero. Liquid air is approximately two and a half times colder than carbon dioxide snow; it is easily applied on a piece of cotton wool twisted round a piece of cane.

The drawbacks to its use lie in its cost and rapid evaporation. It is said to produce very little pain, except when applied to the ear or over the superficial nerves.

It has been specially recommended in cases of large superficial nævi, known as "port-wine stains," but even in these a recently introduced method of applying carbon dioxide snow, which I shall deal with later on, bids fair to replace it.

## THE ADVANTAGES OF CARBON DIOXIDE OVER LIQUID AIR.

The advantages of carbon dioxide snow over liquid air are manifold. The materials and apparatus for preparing, collecting and applying it can always be kept ready at hand, whilst the actual preparation of the snow itself occupies but a few minutes, and its cost is small. The temperature produced by the snow is nothing like so low as that which can be produced by liquid air; but, on the other hand, the methods of applying it are exceedingly simple, and require but a limited amount of skill. With the snow properly prepared, a temperature of 79 degrees centigrade below zero can be obtained. This is sufficiently low for the large majority of cases which fall into the hands of the general practitioner and dermatologist.

Before entering into a description of the therapeutic effects and methods of applying carbon dioxide snow, I will first describe the methods and apparatus necessary for its scientific preparation.

## CARBON DIOXIDE GAS AND ITS PROPERTIES.

Carbon dioxide gas is sold in wrought steel cylinders, Fig. 1, in which it is compressed to the point of liquefaction. These cylinders can be obtained in every large town, the gas being used largely in the preparation of aerated waters, and for other purposes which do not concern us here. Cylinders can be purchased containing a measured quantity of the compressed gas, which is sold by weight, and they vary from small ones containing four lbs. to very large ones, containing as much as 28 lbs.

The pressure or tension contained in the cylinders is from 840 to 1,000 lbs. to the square inch, but varies, of course, with the temperature. On an average, it is probably about 950 lbs. to the square inch or 65 atmospheres. Liquid carbon dioxide has a coefficient of expansion larger than that of any known body, and its boiling point is 72·2 degrees, under a pressure of 760 m.m.

Each cylinder is provided with a stop-cock, which can be opened by means of a special key (which is always provided) and a screw nozzle for connecting it with any tube or apparatus necessary.

The relative positions of the stop-cock and nozzle differ in the bottles supplied by various firms. In some the stop-cock is at the side of the neck, and the nozzle at the end ; in others the positions are reversed.

When the nozzle is opened and the semi-

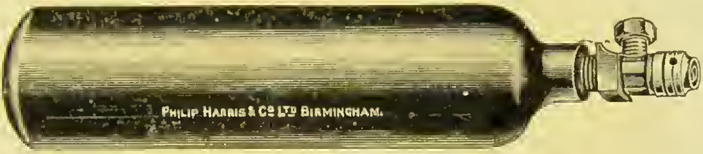

Fig. 1.—Wrought steel cylinder containing carbon dioxide gas, compressed to a fluid state.

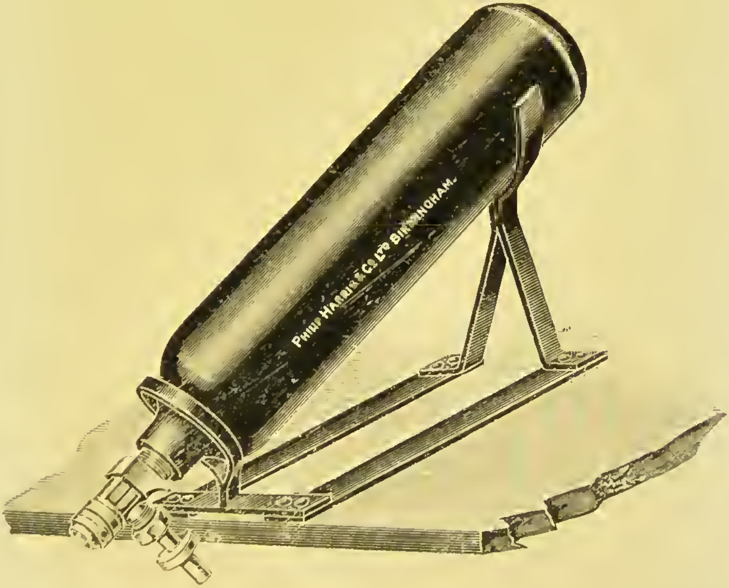

Fig. 2. Stand for holding gas bottle in the position necessary to allow the fluid to escape into the collector.

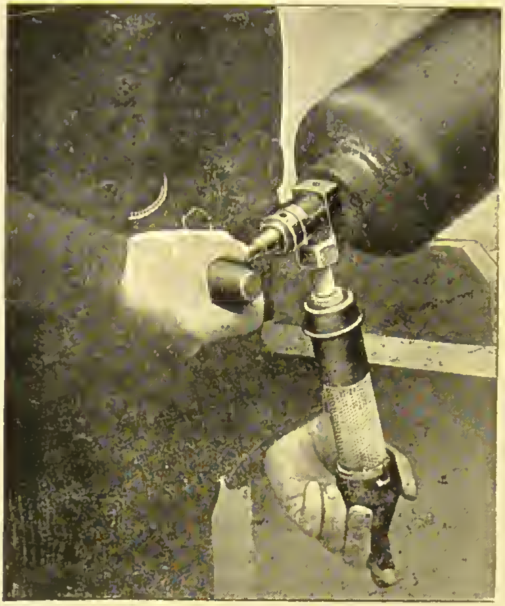

Fig. 3.—Method of collecting the snow with the old form of apparatus.

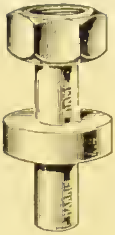

Fig. 4. Nipple and union for fixing to the cylinder, carrying tapered plug which fits into the top of the collector.

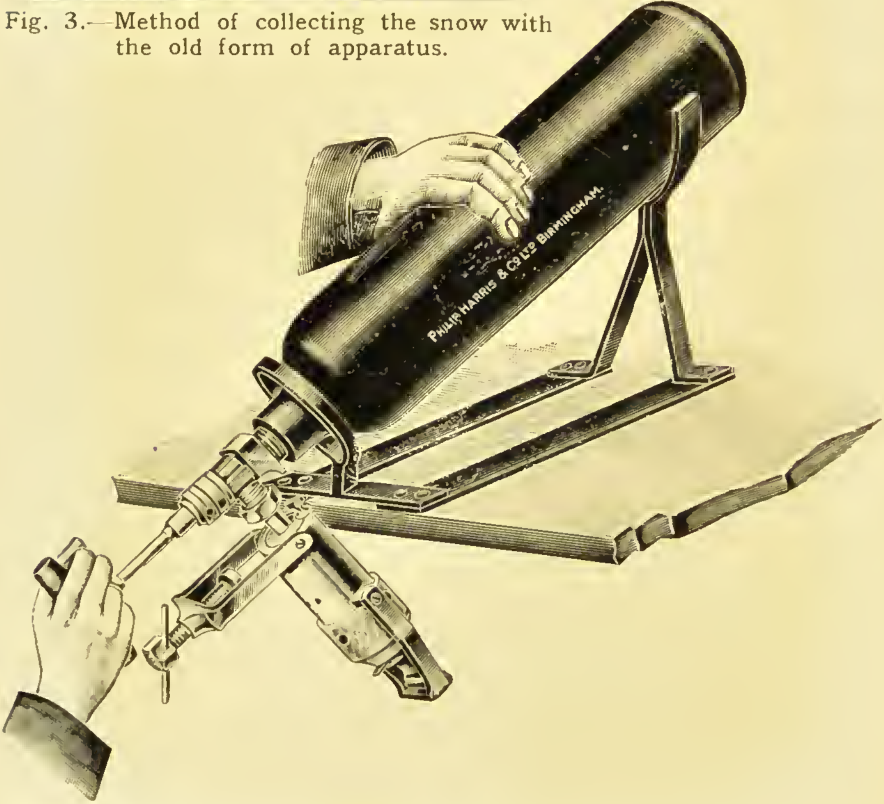
PHILIP HARRIS & Co LTD BIRMINGHAM.

Fig. 5.—Gas bottle in holder showing collector in position, and method of turning the stopcock by means of the key.

fluid gas is allowed to escape into the atmosphere, the sudden expansion causes a rapid fall of its temperature, and a fine snow is formed, having a temperature of 79 degrees centigrade—110 degrees F. At 78 degrees centigrade the carbon dioxide returns to the gaseous state. For the purpose of collecting snow, it is necessary that the cylinder should be inverted, or at any rate tilted, so that the stop-cock and nozzle are on a much lower level than the base. The best results are obtained by holding the tube in an inverted position, by means of a metal tripod or other device; but as it is exceedingly difficult to turn the stop-cock on and off in this position, I have designed a stand which holds the bottle firmly, and at the same time gives it the necessary tilt. (See Fig. 2.)

If a folded-up towel, or a piece of wash-leather or lint, be tied or held over the nozzle, whilst the key is slowly turned so as to release a good flow of the gas, the snow will collect inside. On examination, this proves to be a white powder, which can be compressed like ordinary fine snow. It is extremely cold, but can be handled with safety so long as it is not pressed upon the tissues.

## EARLY METHODS OF COLLECTING THE SNOW.

In the early days of the use of carbon dioxide snow as a therapeutic agent, the following method was advised for collecting. An ordinary huckaback hand towel was folded into three, lengthways, and wrapped tightly round a ruler or piece of metal tube about one inch in diameter. A cork or wooden plug was fixed into the lower end, and the upper end was placed over the nozzle of the gas-bottle, where it was kept in position and from unrolling, by means of a bandage. The stop-cock was now turned on until the interior of the towel was filled with the snow. On removing and unrolling the towel, a stick of lightly compressed snow somewhat resembling a large candle was found filling the tube. If the procedure had been carefully carried out, the stick of snow should be sufficiently hard for use ; if, however, this was not the case, the stick was crumbled up, and the snow placed in moulds, made of wood, metal, or vulcanite in which it was further compressed by means of a rammer, and possibly with the help of a mallet. By having at hand a number of moulds, a stick or crayon of compressed snow of any desired shape could be prepared.

## THE COLLECTOR AND HOW TO USE IT.

On my adopting carbon dioxide snow as a therapeutic agent, I was soon struck by the crudity and wastefulness of this method of collection, so with the object of overcoming these difficulties, I designed a collector and applicator which possessed distinct advantages. My collector not only admitted of the obtaining the small and necessary amount of snow for one treatment without undue waste, but it rendered it unnecessary to transfer the snow from one piece of apparatus to another in order to properly compress it and produce a stick or crayon of the desired size. The collector consisted of a tube formed from a sheet of perforated zinc or tin, inside which is a smaller tube of copper wire gauze, and between the two a lining of soft material composed of a piece of felt and a layer of fine linen. The complete tube, about 8in. in length and 2 in. in diameter, was furnished at its upper end with a brass mount or ring, which was slightly tapered internally. At its lower end was attached a vulcanite tube, which constituted a mould for compressing the snow into tablets. The open lower end of this mould was stoppered during the collection of the snow by means of a vulcanite plug. To the nozzle of the gas-bottle was attached a tube provided with a tapered brass plug which fitted accurately into the upper end of the collector. To obtain the snow, the collector was held firmly in contact with the tapered brass plug, whilst with the other hand the stop-cock was gently opened by means of the key. (See Fig. 3.)

I first exhibited my collector at the Annual Meeting of the British Medical Association, held in London in 1910, and published a description of it and of various forms of applicators, in "The Lancet," of July 8th, 1911. Although it answered its purpose very satisfactorily, I have altered the design from time to time until the present form of collector is nearly perfection. First of all, the collector itself has been improved by covering the perforated zinc with a brass tube, in which a few small holes only were made, for the escape of the waste gas, and hard wood (lignum vitæ) is substituted for the vulcanite, which was easily broken by rough usage

This improvement allows only of a minimum of waste, whilst it enables the collector to be handled freely without risk of freezing the fingers. The nipple and union for fixing upon the cylinder carrying the tapered plug which fits into the upper end of the collector is now so made that the collector fits it accurately, and when in position its upper edge is on a level plane with the upper surface of the plug. (See Fig. 4.)

By means of a little metal button fixed to the edge of the collector, the latter can be held in position firmly against the plug, thus freeing the left hand of the operator. (See Fig. 5.)

It was early found that the tablets or cones of snow prepared by this means could not be sufficiently compressed by hand. An apparatus was therefore devised for putting on the necessary pressure by means of a screw. (See Fig. 6.)

Having compressed the snow as tightly as possible by manual pressure, the collector and rammer were placed in this device, and the screw tightened until the necessary compression was obtained. A lightly-compressed cone will float upon water ; the test of complete and proper compression is that the cone should sink. This process involved two pieces of apparatus. In the latest form of collector (Fig. 7) the device for bringing about this pressure is attached to the collector itself, and being fixed thereto by means of movable joints, it can be swung out of the way when not required, without interfering with the efficiency of the instrument.

At the lower end of the collector is also fixed a swinging stirrup of metal, which holds the lower plug in position. (See Fig. 7.) This plug has also been improved by being hollowed out in its interior, so that the compressed tablet of snow is provided with a cone-shaped end, thus enabling a flat circle of any size being obtained by simply cutting off a piece of the cone in any desired place. (See Fig. 8.)

Fig. 7 shows the complete collector, and the various attached parts, and with the aid of the names of those parts, and the description printed on the opposite page, is self-explanatory, and needs no further comment here.

## THE COMPRESSED CONE OF CARBON DIOXIDE AND THE APPLICATOR.

The preparation of a compressed tablet or cone occupies but a few minutes, and is carried out as follows :—The compressor is first screwed out to its full extent, and the stirrup holding it, being swung aside, the collector is attached to the nipple union and fixed in position in the manner before described, care being taken that the lower stirrup is holding the plug in its proper position. The stop-cock of the gas bottle is now slowly opened, and after a few seconds it is turned off and the collector removed, in order to ascertain that a sufficient amount of snow is attached to its sides. A little practice is necessary to obtain the required amount without waste, but this is easily attained after using the instrument a few times. It is necessary to examine the collector from time to time in order to ascertain that it is not over-filled, as this constitutes the only source of danger possible. If the collector is jammed tightly with snow, and the holes through the jacket are stopped, the contents of the collector may be blown out on removing it from the attachment to the gas bottle.

With the aid of the rammer some of the snow is detached from the sides of the collector and pushed to the bottom, care being taken to only deal with a small quantity at a time, which should be well rammed down before more snow is pushed upon it, or it will be found that after the forcible compression has been applied the point of the cone is not sufficiently hard and may crumble away. When a sufficient amount of snow has been pushed to the bottom of the collector, and compressed as tightly as possible by means of the hands, the upper stirrup carrying the

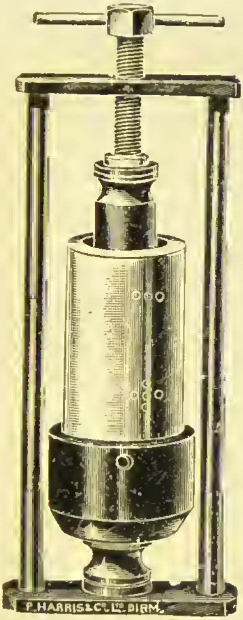
P. HARRIS & Co. Ld. BIRM.

Fig. 6.—Screw clamp for compressing the snow in the old form of collector.

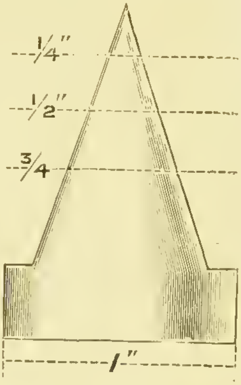

Fig. 9.—Diagram of compressed snow, showing broad base and cone-shaped projection. The transverse lines indicate the positions for cutting off the cone so as to produce a circle of any desired diameter.

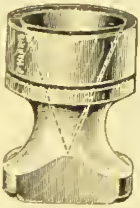

Fig. 8.—Diagram of plug removed from lower end of collector, showing the hollow in which the cone of compressed snow is formed.

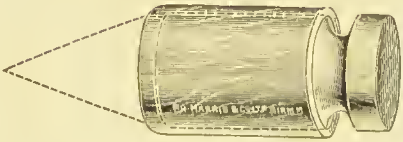

Fig. 10. The applicator showing cone of compressed snow, projecting from its lower end.

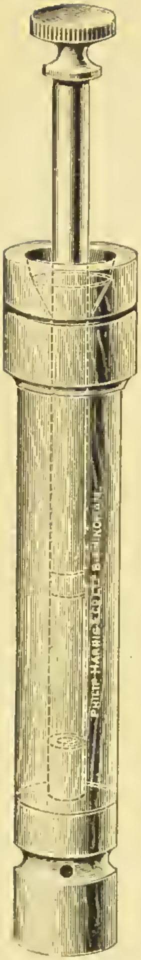

Fig. 11.—The special rammer designed to fulfil the duties of compressor for preparing a stick of snow, showing compression rod in position.

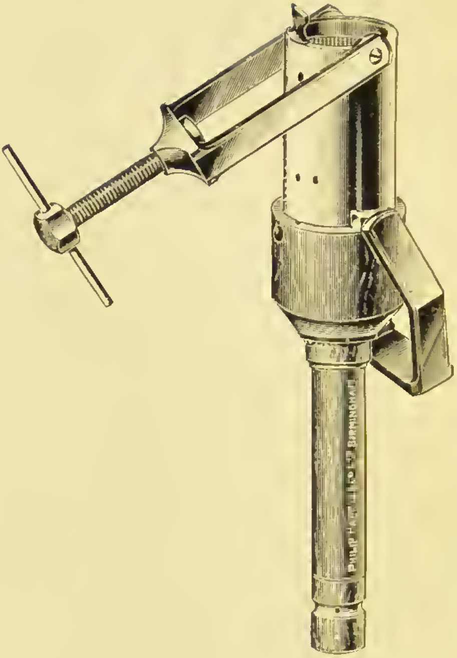

Fig. 12.—Hollow rammer fixed in base of collector in position to receive the snow.

compressing screw is brought over and in contact with the top of the rammer.

The screw is now slowly turned until sufficient pressure is obtained; it is then loosened, and the stirrup carrying it is swung aside. Before pushing the bottom stirrup aside, the wooden plug at the bottom of the collector is given a slight rotary movement by means of the fingers. The object of this is to prevent the snow sticking in the plug, and to preserve the cone intact. The plug is now removed, and with the aid of the rammer the compressed snow is pushed through the lower opening. Sometimes the pressure of the hand is not sufficient to dislodge it, in which case the screw is again placed in position on the top of the rammer, and a few turns given, when the compressed cone is easily forced out. If the operation has been properly carried out, there should be fixed to the base of the cone, about half an inch in thickness of compressed snow, the full size of the collector. (See Fig. 9.)

The compressed cone thus produced is a little more than an inch and a half in length, and an inch in diameter at its base. In this condition it would be difficult to handle and apply it. I have, therefore, devised an applicator which holds it firmly, can be easily handled, and which will admit of the proper amount of pressure being given with ease and certainty. This is composed of a wooden tube, the internal diameter of which just holds the base of the cone, its lower edge being narrowed so that when the cone is inserted the tapered point only projects. On the top of this is placed a cylinder of wood fitting the tube, which enables the compressed snow to be held firmly. (See Fig. 10.)

As the applicator does not admit of the full diameter of the base of the cone passing through its lower aperture, it can only be used when the surface presented by some portion of the cone is sufficiently large to cover the diseased area. If the full size of the base be required, the compressed snow must either be applied by grasping the cone with a piece of lint, or the cone can be held in the wooden plug, Fig. 8, whilst the flat base is applied to the skin.

## THE PREPARATION OF A STICK OF COMPRESSED SNOW.

In the treatment of warts, where the pressure has to be maintained for a comparatively lengthy period, it is frequently advantageous to prepare the compressed snow in the form of a stick of the diameter of a lead pencil, and from 1½in. to 2in. in length. A separate piece of apparatus is necessary to produce this, but in order to minimise space, and to make the apparatus complete, I have so devised the rammer that it can be used for this purpose. The rammer, made of hard wood (see Fig. 11), is composed of three parts, the central part, about 6in. in length, is bored, the tube formed being lined with vulcanite. A plug of the same diameter is fixed at its lower end, and it is also provided with a rod or rammer having a knob on its upper end. At its lower end it is furnished with a hard wooden button, which acts as an insulator. The upper end of the lined wooden tube is made exactly to fit into the lower end of the collector in the position usually occupied by the plug. (See Fig. 12.)

In order to prepare a stick of snow, the collector is partially filled, the plug at the lower end is then removed, and the upper end of the rammer is fixed in its place. With a long metal rod (also provided) some snow is detached from the sides of the collector, and pushed into the lined tube; when this is from half to three-quarters full, it is removed, the plug again placed in position, and the stirrup brought down to hold it. The short metal rod (Fig. 13) is now inserted into the vulcanite lined tube, and the snow is compressed as hard as possible with the hands. The whole contrivance is now placed in the collector, the upper stirrup is brought forward, and by the aid of the screw the snow is further compressed to the desired hardness. Should the amount of snow first pushed into the tube be too large to allow of the contrivance being inserted into the collector as described, the plug can be removed from the bottom of the collector, and the rammer inserted, until it rests upon the lower stirrup; when there should be plenty of room to bring the screw in its position, granting even that the vulcanite lined tube be nearly filled. Should the amount of snow be insufficient to produce a stick of the desired length, the process can be repeated.

## PRECAUTIONS IN USE OF COLLECTOR: HOW TO KEEP IT IN ORDER.

Although the collector has been used many thousands of times and no accident has so far been reported, it may be well for me here to point out that caution must be exercised in using it, and that the instructions herein contained should be followed out as closely as possible.

On turning the stop-cock the key must always be held firmly in the hand, and the stop-cock opened slowly and evenly. A jerky movement may cause a rush of gas, which is, to say the least, highly undesirable. Indeed, to avoid accidents, it is as well, if the bottle has not been used for some time, to slowly open the stop-cock and see that there is a free escape of gas before the collector is placed in its position. Another point which I may mention is that no attempt should ever be made to fill the collector with the gas bottle in the upright position, for unless some of the fluid gas is allowed to escape into the collector, no snow will be formed. The apparatus should be kept in a dry room, and all the wooden parts should, from time to time, be rubbed over with vaseline, especially the interior of the lower chamber of the collector, and of the plug. This not only prevents the wood from swelling and softening, by the condensation of the moisture upon it after it has been used, but it enables the compressed tablets to be removed, when formed, with ease and certainty.

## TRANSPORTING AND KEEPING THE COMPRESSED SNOW.

It occasionally happens that the snow is required for use at a patient's house. Under this circumstance, one must either take with him the whole apparatus, including the cumbersome gas-bottle, or some means must be adopted to preserve the compressed cone for the necessary length of time.

A well-compressed cone of snow can be retained in a usable condition for an hour, if it be packed lightly in cotton wool contained in a wooden or cardboard box. It will keep slightly longer under compression in the collector, especially if the latter be wrapt lightly in a towel or piece of lint. When the snow has to be transported a considerable distance, a Dewar's flask should be used. The flask shown in Fig. 14 I have found exceedingly useful for this purpose. It measures about seven inches in length, and its diameter is such that the compressed cone with base can be easily placed in it. It is provided with a rubber plug, having a hole through its centre through which the gas can escape. It is best carried in a wooden box, packed lightly in cotton wool. By this method, the cone can be kept in a useable condition for a space of about four hours.

## CARBON DIOXIDE SNOW IN SOLUTION : HOW TO PREPARE AND APPLY IT.

Up to quite recently difficulty has been experienced in applying the snow to certain inaccessible parts, such as the interior of the nose and other cavities, and to the recesses of large ulcers where pressure cannot be applied. Thanks, however, to a most valuable suggestion made by Knowsley Sibley in "The Practitioner," of July, 1912, we have now at hand a method of using the snow which largely enhances its value. The snow is insoluble in water, and when placed therein (unless heavily compressed) it floats about on the surface, evaporating at the usual rate, whilst it produces only a slight lowering of the temperature of the fluid.

This is due to the fact that a cushion of gas separates every particle of snow from the water, and thus prevents the two bodies coming into absolute contact. Chloroform and rectified spirit act in the same way, but to a lesser degree. With ether and absolute alcohol, however, the snow forms a perfect mixture which can be used as a therapeutic agent. To prepare this mixture, a quantity of the snow is first obtained in the collector, and by means of the rammer this is pushed into a vessel containing two or three drachms

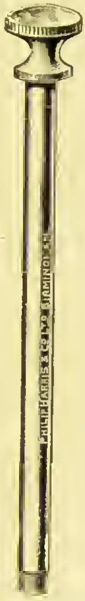

Fig. 13.—Metal plunger for compressing the snow inside the rammer.

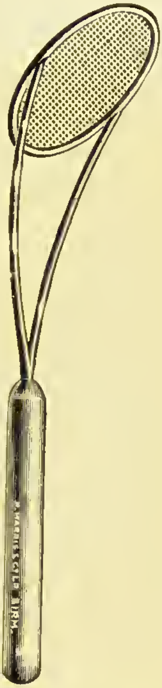

Fig. 15.—Compressor, made of ring of wire covered with wire gauze, for use with dissolved snow

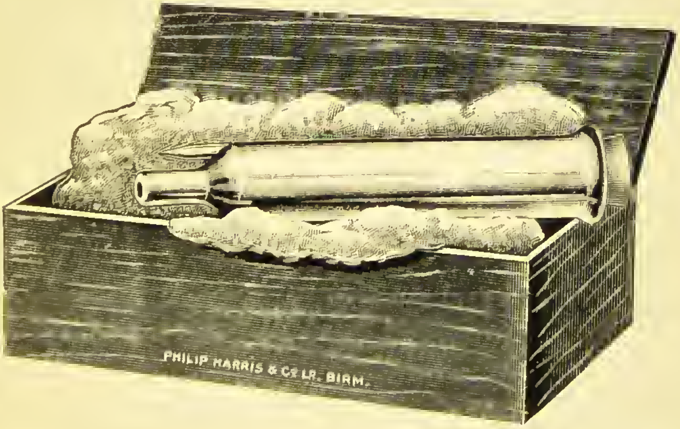

Fig. 14.—" Dewar " flask for holding compressed cones of snow, showing rubber bung with central hole for escape of gas, cotton-wool and box for transportation.

of absolute alcohol or ether, until a colourless semi-gelatinous mass is formed. When the first addition of snow is made to the ether, it appears to boil and to evaporate very rapidly, but a few experiments will prove that the evaporation is principally that of the gas, for as soon as the ether or absolute alcohol reaches the temperature of the snow itself, the bubbling ceases, the snow evaporates less rapidly, whilst the volatile fluid hardly evaporates at all.

Indeed, if the fluid is allowed to stand till all bubbling has ceased, it will be found to consist of the solvent only, which may be decanted into a bottle for future use.

Sibley says :—" This mixture is what may be considered, for all therapeutic purposes, a preparation of liquid air, but without its unstable character and dangerously low temperature. This liquid can be applied very conveniently on a camel's hair brush, or with a swab of cotton wool on a wooden or non-conducting holder. In this way, a liquid freezing preparation can be painted on the skin, as a stimulating or as a cauterising agent, according to the length of time the reagent is applied. When first painted on the skin, a slight crackling sound is produced as if the area were being burnt, but no visible fumes are evolved. The area touched is immediately frozen, and it can be readily maintained in this condition as long as desirable, by continuous applications of the freezing mixture with a brush.

" Only more or less superficial lesions can be dealt with by this method, as it is not possible to exert any great amount of pressure, the degree of which is so important in treating deeply-seated lesions with solid carbon dioxide. A certain amount of interrupted pressure can be exerted by applying the remedy on a swab in a non-conducting holder for a few seconds at a time. If, however, a deeper action is required, a well-compressed lump of solid carbon dioxide, such as is usually prepared for ordinary application, may be soaked in ether or absolute alcohol, and then applied in a pair of forceps to the skin. A firm superficial solid frozen patch is at once produced on any area over which the preparation is passed, followed by the usual sequelæ—bleb, ulcer, and thin pale scar."

I have used the freezing mixture thus prepared since the day of publication of the number of "The Practitioner" which contained Sibley's suggestion, and have obtained very satisfactory results. It produces a lower temperature than the snow in the solid form, and is especially useful for stimulating large patches of lupus, prior to the application of x-rays, in the treatment of large port-wine stains, and for painting out large indolent ulcers. The question of pressure is one which I have overcome in the following way. I have devised a special compressor constructed from a ring of wire, covered over with a fine metal gauze, and supplied with a handle which enables the instrument to be firmly pressed upon the skin. (See Fig. 15.)

Having chosen a compressor of the size necessary to cover the area you require to treat, the instrument is pressed down upon the skin by the left hand, and the liquid snow is painted over the wire gauze. The pressure is maintained until the freezing is complete, when the instrument is removed, and the part allowed to thaw, as after the application of the solid snow. The compressors are made in various sizes, and are provided with wooden or vulcanite handles, which allow of their being used without freezing the fingers.

Ether-snow can be used as a stimulant in many conditions in which it would be difficult or impossible to use snow in the solid form. It can also be applied with ease to the interior of the nose, mouth, and, with care, even to the throat. It can be applied also through a speculum to the uterus and vagina, and may even prove useful in the treatment of some rectal conditions.

## HOW THE SOLID SNOW SHOULD BE APPLIED: ITS EFFECTS, LENGTH OF EXPOSURE, AND AMOUNT OF PRESSURE NECESSARY.

Having prepared our cone, or stick of snow, and having at hand a suitable case for treatment, the first step is to place the patient in a comfortable and easy position, so that the necessary pressure can be used and maintained during the treatment.

Before the snow is applied to the skin, the latter should be washed, preferably with carbolic soap, and afterwards be wiped over with cotton wool soaked in methylated spirit. Absolute cleanliness is essential to success, for it must be borne in mind that freezing, even to the extent obtainable by the aid of liquid air, does not destroy bacteria. Bacteria have been frozen for a considerable length of time without their having been destroyed. They appear to hibernate in the frozen mass, and on thawing, they start life again with renewed vigour.

The only bad result I have seen, so far, occurred after the treatment of a large nævus, situated on the buttocks of an unhealthy baby, who was allowed to wriggle about in dirty bacteria-laden clothing, the frozen area being unprotected. In this case, bacterial infection was obvious, and a large slough, evidently not due to over-exposure, separated. For a few days the child seemed in a bad way, but rational treatment in hospital speedily proved successful, and, finally, a most satisfactory colourless scar was all that remained.

The cone of compressed snow, after the removal from the collector, is placed in the applicator, in which it is firmly held, whilst it is trimmed to the desired size with the aid of a knife. The skin over the affected area is now stretched between the thumb and first finger of the left hand (see Fig. 16), whilst the applicator, firmly held in the right hand, is applied to the desired area with firm pressure for such length of time as is deemed necessary to produce the required result.

The pressure should be sufficient to drive the blood out of the part, or to arrest the circulation. The freezing of the skin gives very little pain—certainly not more than can be borne by the average individual—and children frequently bear it without complaint. The immediate effect of the application of the snow is the formation of a hard white china-like area, corresponding in size to the piece of compressed snow applied. (See Fig. 17.) This area is, as a rule, depressed below that of the surrounding skin, the amount of depression corresponding with the pressure used in its application and with the elasticity of the tissues to which it is applied. The time usually occupied in the application of the snow depends upon the nature and position of the lesion attacked, and may vary from five seconds to a minute, or even more.

In very superficial nævi, from five to twenty seconds is usually sufficient, consideration being taken of the age of the patient, and of the sensitiveness of the skin. In treating nævi, the snow should be applied firmly, with sufficient pressure to drive the blood out of the part, and to arrest circulation. The average duration of the application varies between twenty and sixty seconds. In cavernous nævi, the application must be sufficiently lengthy, and the pressure sufficiently strong to freeze the whole mass. The length of exposure and amount of pressure can only be decided by a knowledge of the condition present, and as the result of observation and practice. Great care must be taken not to administer an over-dose, and special care must be exercised when dealing with babies and young children, and where the lesion is situated immediately over bone.

It is inadvisable to apply refrigeration in very old people, or to those suffering from broken down constitutions. The use of snow is also contra indicated in cases of arterio-sclerosis and nephritis.

In very superficial conditions, the exposure must be short, and the pressure slight. It is far better to err on the side of under exposure, as the application can always be repeated if the desired effect is not attained on the first occasion.

In the deeper forms of lesions, the applications may be prolonged, and in treating corns and warts, the application may be continued until a ring of the normal skin is frozen around the growth.

In dealing with large warts, as much as possible of the hard dead epithelium should be removed before the application is made. Over-exposure may result in the formation of an ulcer, which may leave a permanent and ugly scar, and great damage may be done by over-stepping the limits, either in regard to the length of application, or the amount of pressure used.

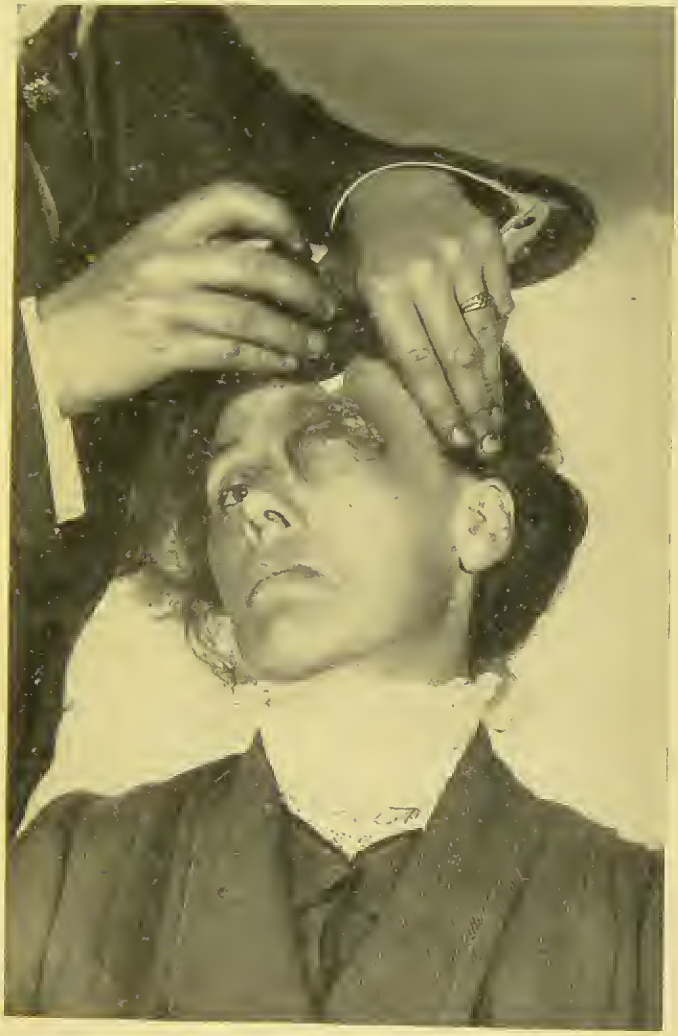

Fig. 16. Method of applying a cone of carbon dioxide snow contained in applicator. The skin is stretched between the thumb and first finger of the left hand, whilst the compressed snow is applied with the right hand.

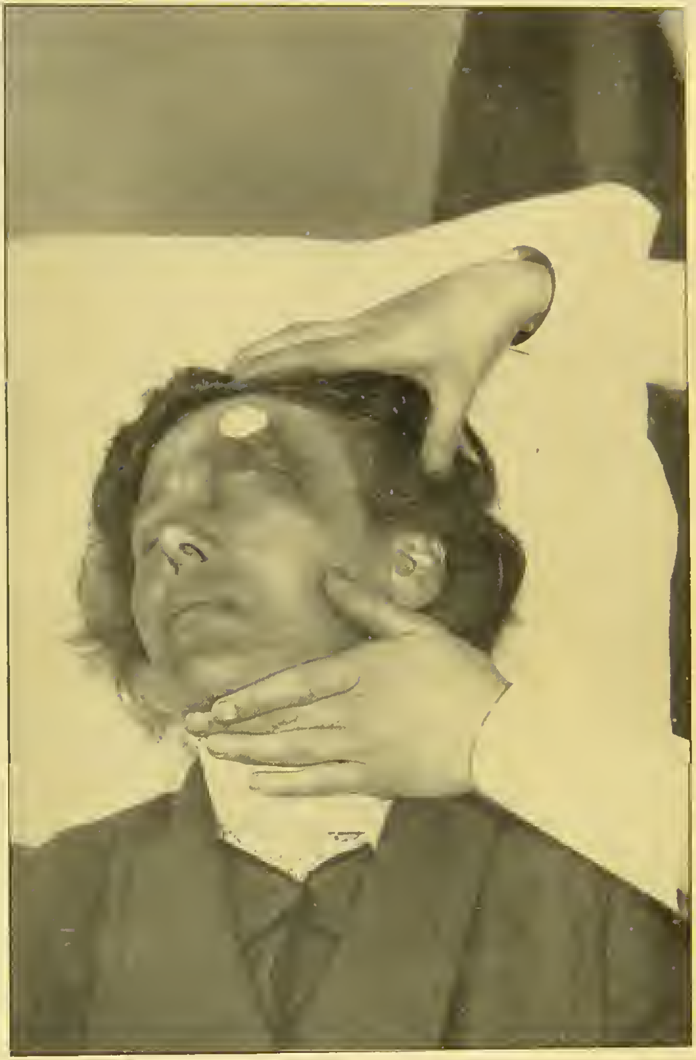

Fig. 17.—Untouched photograph showing china-like white surface produced by the application of solid carbon dioxide snow. Photographed immediately after the application, and before thawing commenced.

In dealing with carbon dioxide snow it must be remembered that, like many other therapeutic agents, a dose which may give a satisfactory result in one case, will be found to produce little or no effect upon another. There exist undoubted idiosyncrasies, and the resistance of the tissues varies. The degree of decolorisation produced by the pressure of the fingers acts as a guide to the pressure which should be applied, whilst the colour of the patient's skin, and its delicacy, are factors which must not be overlooked.

Freezing by carbon dioxide differs from that produced by ethyl chloride, in that when using the latter, after the surface is once frozen, it protects the deeper tissues, and prevents the extension of the freezing, whilst with solid carbon dioxide, the longer the pressure is maintained, the deeper the freezing penetrates. Thickened skin presenting a horny layer protects the subjacent tissues from freezing, hence, in these conditions, the length of exposure and the amount of pressure must be greater than when applied to a normal skin surface.

An application occupying but a few seconds

—five to six—produces a marked reaction, but no blistering. Blistering rarely occurs after an application occupying less than twenty seconds, and under this circumstance no scar is left. With the more lengthy applications—thirty to forty seconds—there is intense reaction, some destruction of the tissues, and a scar always results. This scar, as a rule, is soft and pliable, and after a time approaches the normal skin in colour. In a very long application, in from one to two minutes or more, the skin is, of course, killed. No blister is formed, except at the edges, and a slough always results.

## THE AFTER TREATMENT OF LESIONS PRODUCED BY FREEZING.

Immediately following the removal of the compressed snow from the skin, thawing commences. The process takes longer than that of freezing, and is accompanied by slightly more pain. When thawing is complete, little difference will be noticed, with the exception of a slight redness, but reaction soon sets in. Within a few minutes, the tissues become firm to the touch, begin to swell, and a wheal forms. A vesical nearly always follows an application of more than thirty seconds, and generally makes its appearance in from one to three hours' time. It is well in most cases to puncture this with a sterile needle, after which it should be dressed with some antiseptic but non-irritating ointment. In from four to five days after a successful application a scab should form, which, unless there be pus underneath, should be allowed to separate of its own accord.

No necrosis or sloughing should follow an application properly administered and carefully dressed. Necrosis, however, can be brought about by repeated applications given at short intervals. Recovery should be complete in fourteen days, when a perfectly smooth surface of a delicate pink colour should result. This surface becomes paler as time goes on, until ultimately a pale, soft, pliable, elastic scar should remain, which should compare favourably with that produced from the action of radium, or any other cauterising substance.

The treatment necessary after the application of snow is exceedingly simple. Apart from the pricking of the vesical, absolute cleanliness, protection from rubbing, and the application of a simple ointment, is all that is required.

Morton advocates the use of boracic acid ointment. I prefer the oleate of zinc or simple ointment containing two per cent. of carbolic acid.

Cranston Lowe prefers a mild antiseptic dressing consisting of zinc paste with hydrarg. ammoniat. 5 grains to the ounce. This, he says, prevents infection of the surface. Pusey suggests that the area should be washed over twice daily with a solution of peroxide of hydrogen. He depreciates the use of antiseptic powders, which cake upon the surface of the skin, and allow pus to collect beneath.

The same care must be exercised in dealing with the after results of refrigeration as should be taken with any other form of lesion. Bacterial infection has chiefly to be guarded against, or erysipelas and other diseases may result.

Sloughing is to be avoided by paying the greatest possible attention to technique, and by the surgeon refusing to apply the snow in unsuitable cases. Should sloughing accidentally occur, it must be treated in exactly the same way as would a similar condition from any other cause ; it being kept in mind that the main aim in view is to avoid scarring.

I have elsewhere laid stress upon the class of case in which extra precautions should be taken, and upon the conditions in which an application should be avoided. The ultimate decision as to advisability, or otherwise, of applying snow in any given case, must rest with the surgeon himself, after taking into account all its bearings.

Scarring necessarily follows a lengthy application, no matter how carefully the after treatment be carried out, and it is of little consequence when situated upon the covered parts, whilst in many instances it is preferable to the unsightly condition which it has replaced.

An important question arising out of scarring is the possibility of degenerative changes taking place in the scar-tissue. One or two cases have been reported in which malignant growths have made their appearance, but in these, other methods of treatment had also been adopted, and there was no direct evidence that the carbon dioxide snow was responsible.

The scars following snow treatment are, as a rule, better than those produced by other methods, and it is satisfactory to note that in no case so far has keloid of the tissues resulted.

Personally, I deeply depreciate the treatment of large areas at one sitting. Such procedure is a frequent source of accident, and under no circumstance should it be undertaken unless the patient can be kept in bed and under constant supervision.

## THE PHYSIOLOGICAL AND THERAPEUTIC EFFECTS OF FREEZING BY MEANS OF CARBON DIOXIDE SNOW.

Although the process involved in the action of carbon dioxide snow upon the tissues is one of refrigeration, it differs from ordinary freezing and frost-bite in some important respects.

The first noticeable effect of cold is blueness of the skin, due to slowing of the circulation, and contraction of the superficial blood-vessels. Later the skin becomes white owing to the complete obliteration of the vessels. The vitality of the tissues is much diminished, and if the low temperature has lasted any length of time, or the thawing process is brought about too rapidly, gangrene, due to stasis and thrombosis, is prone to follow.

There are many other changes which follow lengthy exposure to low temperatures which do not concern us here.

The local effects of excessive low temperatures, such as are produced by contact with snow, ice, or cold metal in the arctic regions, are divided into three stages or degrees :—

1st, the production of an erythema, with swelling, and œdema of the skin, a condition frequently followed by chilblains.

2nd, the formation of blisters in addition to the erythema.

3rd, necrosis of the tissues ending in the death of the skin and the subsequent separation of a slough. This condition is made worse by sudden thawing, and is sometimes followed by severe constitutional disturbance accompanied with albuminuria and general septic infection.

Until quite recently nothing was known of the effects of such excessively low temperatures as are producible by the application of liquid air and carbon dioxide snow. The same three degrees of refrigeration can, of course, be produced, but these are under complete control, and are not followed by constitutional symptoms.

The process of freezing by means of carbon dioxide snow is a purely physical one, the results being entirely brought about by the low temperature produced, combined with the pressure used. As far as we know, the snow has no local action of its own, that is to say, that the chemical itself produces no effect, good, bad or indifferent, apart from the lowering of the temperature of substances with which it is brought into contact.

That the action of the snow is entirely physical can be proved by the fact that if it is contained in a metal receptacle (a teaspoon) which admits of its rapid and uninterrupted evaporation, the pressure of this upon the surface of the skin will produce the same results as when the compressed snow itself is used.

When the area to be treated is a little larger than the compressed tablet or crayon prepared, I have placed a sterilized coin over the part, and applied the snow on the top, the result being the same as when a compressed tablet of the same size as the coin is used. The freezing, of necessity, takes a little longer, inasmuch as the heat contained in the mass of metal has to be first dissipated.

Carbon dioxide snow has no bactericidal action, and experiments show that after prolonged freezing at the extremely low temperature produced by liquid air, for a lengthy period, bacteria still grew as if nothing had happened to them. They appear to hibernate in the frozen mass, and upon thawing regain their activity.

Its action in no way resembles that produced by the galvano or actual cautery, neither are its effects due to cauterising action. Caustics, in great part, owe their action to their great affinity to water, which they absorb from the tissues with such force as to destroy the cells with which they come in contact.

Destruction of the tissues by means of carbon dioxide snow is an after result, and is due to reaction. When the part treated has thawed, it is still living, but local death may subsequently follow as the result of inflammatory stasis, brought on by reaction. In this respect it differs from all caustics, whilst its action is more nearly allied to that produced by the application of radium. When the snow is removed from the skin it leaves a white depressed china-like surface, which is almost as hard to the touch as the snow itself (see Fig. 17).

This hardness and whiteness are due to a combination of causes, chief amongst which are the obliteration of the blood-vessels from the dual effects of refrigeration and pressure, and the formation throughout the tissues of minute crystals of ice due to the freezing of the liquid contents of the cells. The degree of hardness is so marked that neither liquid air nor carbon dioxide snow can be successfully used for producing local anesthesia for small operations: it being almost impossible to cut through the thus frozen tissues.

The destructive action of carbon dioxide snow upon the tissues is due to the dual effects of rapid freezing and rapid thawing. The freezing, it has been said, destroys the cells by causing them to rupture owing to the expansion of their contents at the moment refrigeration takes place.

According to Drs. Stopford Taylor and McKenna :—" The reaction consisted in the copious outpouring of serum, with the formation of a bulla. There was marked diaped~~i~~sis of leuco~~s~~ytes, the connective tissue becoming swollen and enlarged; many of the capillaries became thrombosed, but the epithelium sustained the chief damage, in that in most cases it was completely destroyed.

Some writers have attributed a selective action to carbon dioxide snow. I am, however convinced that it has no such action. The theory of selective action attributed to modern physical agencies, has now generally been abandoned. At one time much stress was laid upon this action, and the theory was undoubtedly responsible for much misconception. If we were to believe all that was said concerning the selective action of x-rays and radium, we should have to admit that, at any rate in the case of radium, it exhibits a selective action which amounts almost to an intelligence, for according to some authorities, it appears to be able to select just the particular cells which the operator desires to destroy or stimulate.

At the present time we are content to believe that young cells are, under certain circumstances, more easily destroyed than the mature ones, and that when they are damaged, they less easily recuperate. Carbon dioxide snow destroys or materially injures all the cells which are actually frozen, but its influence extends no further.

Some pathological cutaneous tissues offer more resistance to carbon dioxide snow than do normal ones, hence an application which would in one case produce a severe reaction, will in another have little or no effect. In certain conditions a short application may bring about an unforeseen amount of reaction. Idiosyncrasies certainly exist, and the only method of avoiding accidents is to give a small preliminary trial before resorting to severe treatment.

## MICROSCOPIC CHANGES IN THE TISSUES BROUGHT ABOUT BY FREEZING SNOW.

That the application of carbon dioxide to the tissues rapidly brings about great changes in them is evidenced by the fact that a wheal forms immediately, followed in a very short space of time by a vesicle. The epithelium, even after a short application, sustains severe injury, and after a long one is completely destroyed. In addition there is a marked diapedisis of leucocytes into the surrounding structures, together with thrombosis of some of the capillaries.

Many of these changes are brought about by the mechanical pressure produced by the formation of crystals of ice either within the cells themselves, or in the interstices between them. It is quite possible that the cell walls are ruptured by the expansion of their contents at the moment of freezing, and that further damage is done by pressure.

When recently dead tissue is subjected to freezing the fluid contents are said to escape, and to form ice crystals. I recently removed a piece of skin from the abdomen of a cadaver, one half of which was frozen for over ten minutes by being packed in carbon dioxide snow. The two pieces were then hardened in alcohol, and after being imbedded in paraffin wax, were cut into sections. A careful examination of a number of the specimens under the microscope failed to show any difference in their structure. That there must be some difference is proved by the fact that the colouring matter of the blood stains the frozen specimen evenly, whilst no such change is noticeable in the non-frozen piece. These small changes are, no doubt, obscured by the process of hardening.

Specimens of skin examined twenty-four hours after freezing show great changes in the epithelium, whilst the connective tissue beneath is infiltrated with leucocytes. The blood-vessels are dilated and thrombi can be plainly seen. No differences are to be observed in the elastic tissue.

The four photomicrographs reproduced (*see inset facing page* 48) show well some of the changes in the tissues which are brought about by freezing.

Fig. 18.—Vertical section of normal skin of guinea-pig × 150.

Fig. 19.—Vertical section of skin of guinea-pig twenty-four hours after the application

of carbon dioxide snow for a period of twenty seconds × 150. The cells of the rete malpighii, which are only faintly stained, are increased in size. Those of the outer layer are much enlarged. The nucleus appears to be detached from the protoplasm, and is surrounded by a clear space, whilst on the outer surface both have disappeared. The section also shows the presence of a vesicle with infiltration of leucocytes. In the corium the connective tissue fibres are more widely separated than normally, probably due to the pouring out of serum between them. There is also a diffuse infiltration of inflammatory cells in this region.

Fig. 20.—Vertical section of skin of guinea-pig on eighth day after application of carbon dioxide snow × 75. The section is made through the centre of scab, and on examination, from above downwards, shows three layers The first and second show the necrotic tissue of the horny and malpighian layers. Examining from left to right the third layer shows the regenerated malpighian layer merging into the necrotic tissue of the scab.

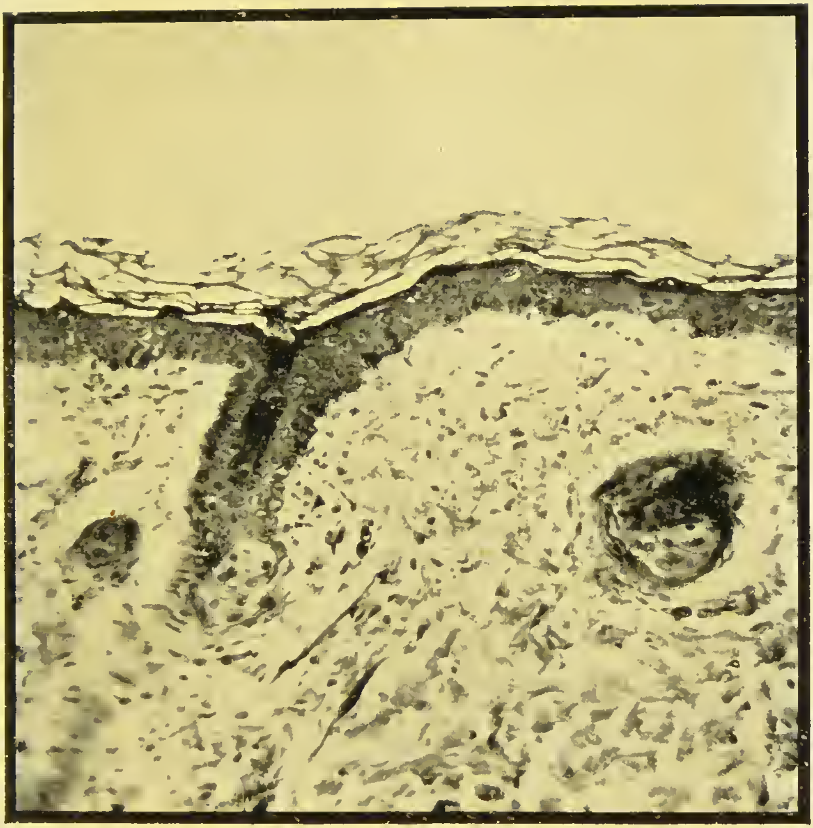

Fig. 18.—Vertical section of normal skin of guinea-pig × 150.

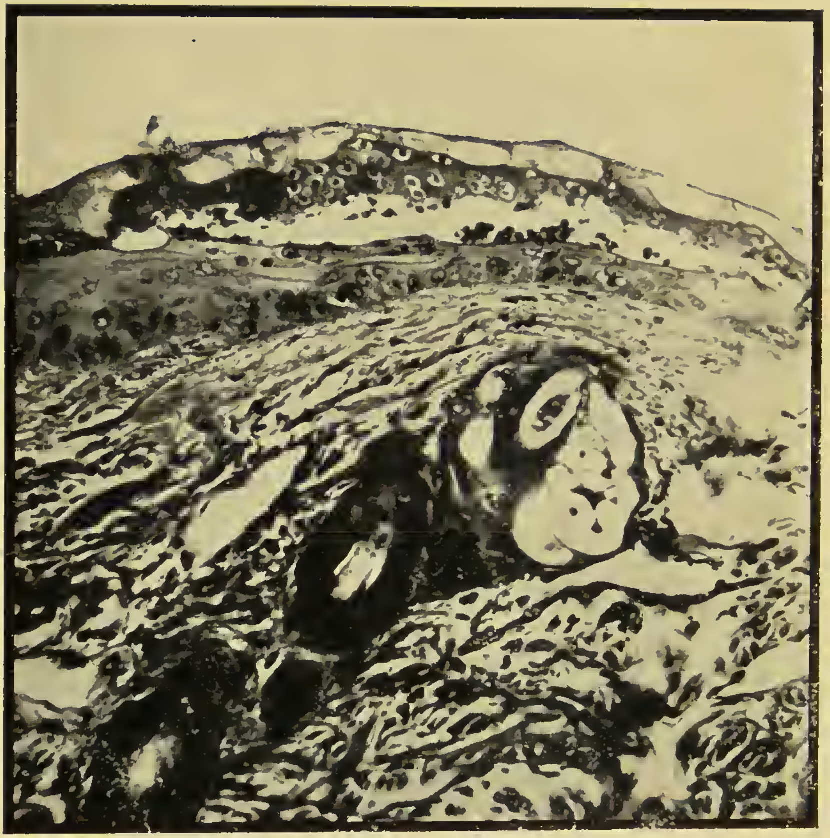

Fig. 19.—Vertical section of skin of guinea-pig twenty-four hours after the application of carbon dioxide snow for a period of twenty seconds × 150.

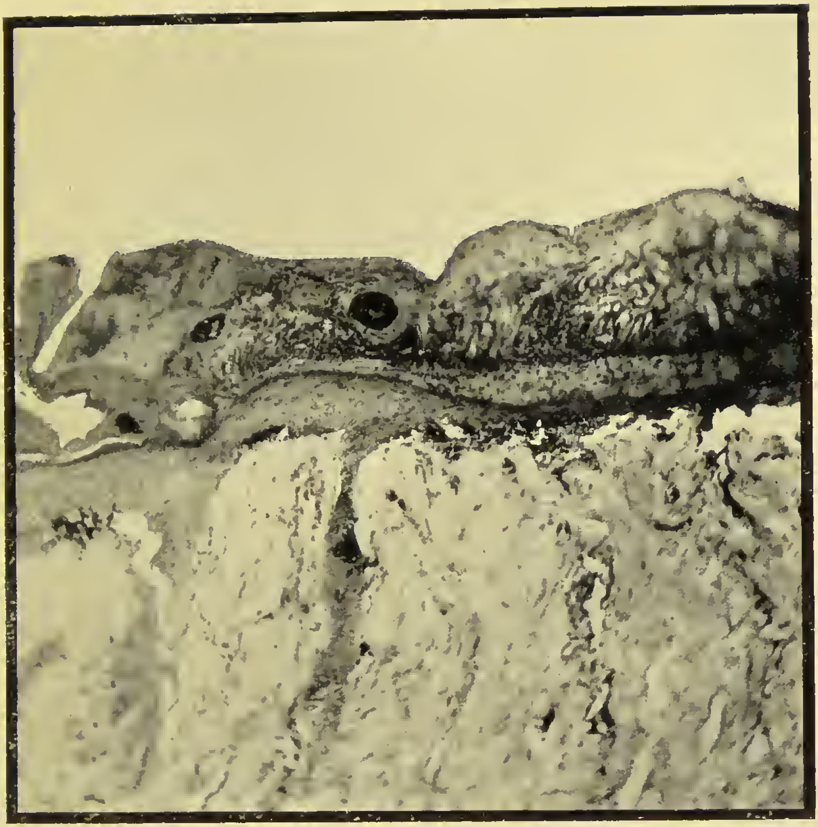

Fig. 20.—Vertical section of skin of guinea-pig on eighth day after the application of carbon dioxide snow × 75.

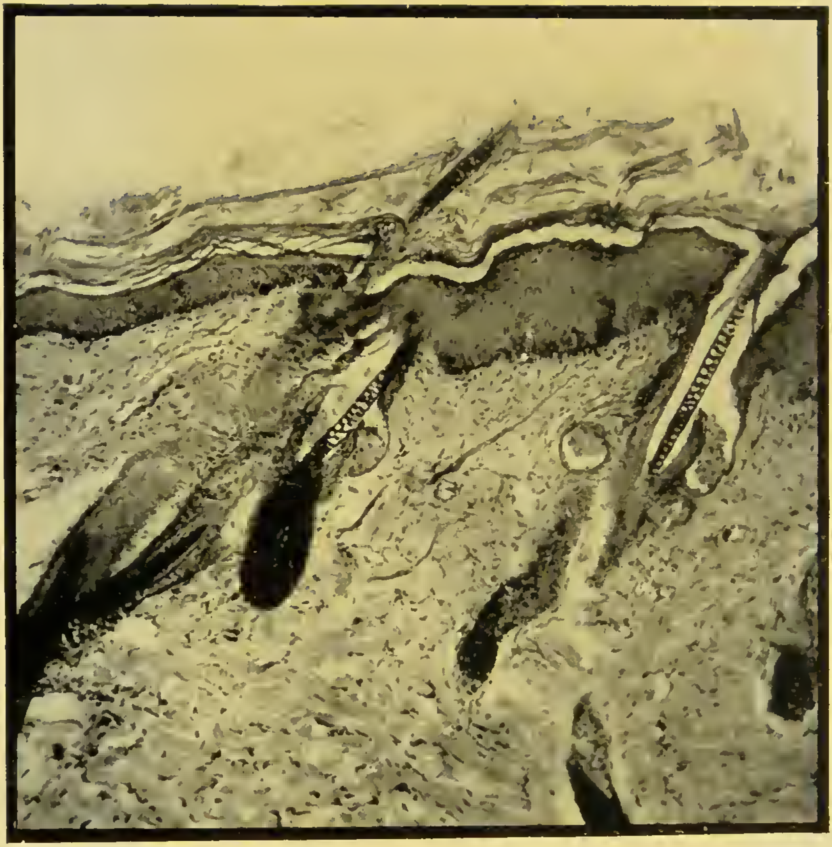

Fig. 21.—Vertical section of skin of guinea-pig from margin of scab. Eighth day after application of snow × 75.

Fig. 21.—Vertical section of skin of guinea-pig from margin of scab on the eighth day after freezing×75. On the left the normal skin is shown, and on the right the inflamed cells of the rete malpighii. Some infiltration of inflammatory cells into the cellular tissue is also observable.

## ON THE USE OF CARBON DIOXIDE SNOW AS A LOCAL ANÆSTHETIC.

Carbon dioxide snow has been used with some success in the production of local anæsthesia. In the compressed form it may be rubbed over the surface of the skin until slight freezing is produced, when a small operation may be performed with little or no pain. I do not, however, advise this method, on account of the difficulty of applying it in a dose sufficient to avoid injury to the tissues, and at the same time to produce the necessary amount of insensitiveness.

In the liquid form, made by mixing the snow with ether, or alcohol, it may be successfully used in the following manner: Either by quickly and lightly painting over the surface, care being taken not to apply the mixture too freely, or when a simple incision has to be made, such as required for the opening of an abscess by the carrying out of the following procedure.

A soft brush filled with the semi-liquid snow is applied to the skin slightly beyond the point where the incision is to be commenced. It is now drawn over the surface in the direction required sufficiently slowly to freeze the tissues to a slight degree only. Immediately the brush is placed on the skin freezing commences, and as soon as the spot first touched is sufficiently frozen, the point of a scalpel is inserted to the required depth; the brush is now slowly moved onwards, followed by the scalpel, until an incision of the desired length is made. It, of course, requires two persons to carry out this procedure; but if done quickly, it is almost painless.

## DISEASES IN WHICH CARBON DIOXIDE SNOW MAY BE USED.

Whilst there are certain conditions in which the therapeutic use of carbon dioxide snow is, perhaps, superior to any other method of treatment, I wish it to be thoroughly understood that it is not my wish or intention to advocate its use in preference to other methods. In deciding what particular therapeutic agent shall be used in a given case, the exact condition must be perfectly understood, and the surgeon must, to a great extent, be influenced by experience.

Carbon dioxide snow has been used in a large variety of diseases with a varying amount of success, but it stands out pre-eminently as an almost ideal method in certain diseases and conditions, upon which I shall have more to say later on.

It has been used with more or less success in the following diseases and conditions :—

Nævi.
Angiomata.

Rodent ulcer.
Lupus vulgaris.
Lupus erythematosus.
Tubercular ulcer.
Lymphangioma.
Warts.
Moles.
Papillomata.
Chronic eczema.
Lichen planus.
Molluscum contagiosum.
Erysipelas.
Benign cystic epithelioma.
Xanthoma.
Psoriasis.
Keratoses (senile and x-ray.)
Diseases of the eye (trachoma, rodent ulcer, and papilloma), etc., etc.

In the above list I have only included diseases and conditions in which favourable results have been reported. Some of these I shall deal with at length. In many other diseases the snow has been tried with little or no result, possibly due to faulty technique.

## CARBON DIOXIDE SNOW IN THE TREATMENT OF NÆVI AND ANGIOMATA.

In the treatment of nævi and angiomata carbon dioxide snow has secured its greatest successes, and if it be applied with skill, a good result can be predicted in many cases. The modern treatment of these conditions, especially by means of radium, have enabled us to cure many cases which were practically untreatable.

Wickham and Degrais, in their book on radiumtherapy, instance a large number of cures in cases which would have offered a poor chance to excision, electrolysis, or cauterisation.

Whilst radium is capable of producing splendid results, and is a painless method of treatment, the fact that it is exceedingly expensive, especially when required for the treatment of large areas, together with the slowness with which the results are brought about, led many to pay attention to the carbon dioxide snow treatment. In many cases the snow is equally effectual, whilst it is much cheaper and much more rapid in its action.

In some forms of nævi, results equal to those produced by radium can be secured in a shorter space of time. In others, there can be little doubt that radium is superior. In the treatment of capillary nævi in young children and babies under one year of age, I prefer to use radium, giving short exposures frequently repeated. In children over this age, carbon dioxide snow may be used, but care must be taken to carefully regulate the time of application and the pressure. The time occupied in the application of snow, and the pressure necessary to bring about a perfect result, depend upon the thickness of the tissues implicated, the age of the patient, and the sensitiveness of the skin.

Pusey states that the skin of an infant under twelve months is three or four times as sensitive to freezing as is the skin of an adult. He also says that the skins of some women, especially of fair ones, react with great vigour, and he recommends that a short preliminary freezing should be given in all cases where any idiosyncrasy is suspected.

Flat nævi are far more difficult to treat successfully than the prominent ones, and better results are produced by short applications following one another, than by attempting to cure them at one sitting. Morton states that ninety per cent. of his cases were cured with one application of about forty seconds' duration. In some of his cases, two, three, or even four applications were found necessary.

Bunch has used liquid air with great success. His method is to apply it by means of a swab of absorbent cotton wool of exactly the size of the lesion to be treated. This he attaches to the end of a stick of wood, which he dips into the flask containing the liquid air.

For capillary nævus, he states, that an application of from five to seven seconds is sufficient, and for cavernous angiomata from nine to ten seconds, whilst for warts, he gives as much as twenty seconds' application with firm pressure.

For reasons already stated, solid carbon dioxide is far superior to liquid air, and it is doubtful if the higher temperature of the latter does not (apart from all other considerations) give it a distinct advantage.

No second application of the snow should be made until the full effects of the first one have completely disappeared. This period may vary from two to three weeks or more.

In cavernous nævi of small size upon the body, one or two applications of the snow are usually sufficient to bring about a cure.

In nævi of large size, several applications may have to be given, and these must be administered with the greatest care, lest sloughing results ; and it must not be forgotten that such nævi are frequently prone to slough spontaneously.

In the treatment of stellate and other forms of nævus on the face, I generally prefer to use radium, but even these can be successfully treated so as to leave no scar, granting that the greatest possible care is exercised during the procedure.

Pusey highly recommends the combined treatment of refrigeration and x-rays. He first exposes the nævus to the x-rays so as to produce a very slight reaction, followed by short applications of the solid snow for about ten seconds. He states that his best results have been secured in this manner, with little or no perceptible alteration of the skin.

In treating nævi which cover a large area, I think it unsafe, and unwise, to expose more than two square inches at a time, and I wait until the reaction has subsided before treating a fresh patch. Bunch says, in order to obtain the best possible scar, it is far better to give too short an application than an over-dose, and he prefers to give two or three applications at intervals of three weeks, rather than run the risk of producing a definite ulcer by a prolonged exposure at one sitting.

In pigmented nævi, especially those covered with hair, several applications of snow are usually necessary, but if care be taken, results may be secured which cannot be equalled by any other method of treatment. These cases can be treated successfully with radium, but it not infrequently happens that this fails to get rid of the whole of the pigment. With carbon dioxide snow the danger is that too white a scar may be produced, and this is only to be avoided by careful regulation of the dose administered. Many cases of large pigmented hairy nævus have been successfully treated by this method. Dore, however, relates a case in which the condition returned after what appeared to be a successful result.

Pusey thinks the best results are secured by the combined treatment of snow and x-rays, previously mentioned. If the hairy growth is profuse, this should be removed, either by shaving or by means of a depilatory, and in all cases the skin should be washed over, first with an antiseptic solution, and then with methylated spirit, prior to the application of the snow.

## CARBON DIOXIDE SNOW IN THE TREATMENT OF RODENT ULCER.

Although the therapeutic agents for treating this disease, have during the last few years increased, not only in numbers, but in efficiency, they cannot even at the present time be said to have yielded those perfect results which were anticipated from them.

For the treatment of small primary rodent ulcers, I have, until quite recently, depended upon the use of x-rays, radium and diathermy. Lately, however, I have tried carbon dioxide snow with good effect as regards immediate results. I am not, however, yet in a position to speak with any amount of confidence as regards recurrence.

Morton, whose experience in this direction is a great one, is of opinion that recurrence less commonly follows the snow treatment than any other method. He says, "My experience so far justifies me in saying that any case of rodent ulcer that is superficial, and has not invaded cartilage or bone, can be completely cured with a single application of solid carbon dioxide, and that the result will easily bear comparisons with any form of radiation or ionization in regard to appearance, and I am equally confident that time will prove it to be even more permanent."

It has more than once been stated in public that rodent ulcer is always amenable to scientific treatment. With this statement I beg entirely to disagree. That small primary ulcers can always be healed by one or other of the modalities at our command I readily admit, but we can give no guarantee for the permanence of cure, or for its non-reappearance.

The difficulties in the way of securing a cure in rodent ulcers which have recurred, and which have attacked bone or cartilage, are, firstly, that the disease frequently extends so deeply into the tissues that some of our therapeutic agents fail to thoroughly eradicate them, and, secondly, that in old ulcers of long-standing we have present, in all probability, a mixed condition of rodent ulcer and epithelioma.

All small primary rodent ulcers respond quickly to x-rays or radium, scientifically applied, but after repeated recurrences, a stage is reached when reaction is difficult to bring about, and when the results of such reaction are disappointing, or not forthcoming. This condition has been said to be due to changes in the tissues, brought about by previous treatments ; but that this is not perfectly true is proved by the fact, that when rodent ulcers have reached this stage without having been subjected to any treatment, by means of radiations, they still refuse to react in the same manner, and to the same degree, as do the primary lesions.

It is in this stage of the disease that my knowledge of the usefulness of carbon dioxide snow has been chiefly gained. I have painted these ulcers over with carbon dioxide snow, dissolved in ether, or absolute alcohol, with good effect, but I have not, so far, given it a trial to the extent advocated by Morton, who has applied the solid snow, over and over again, for a period extending to weeks, before the ulcer had responded and healing commenced.

During the treatment with snow, the ulcers, of course, appear to be much worse, but when the process of healing commences, a marked improvement can daily be observed.

I have principally used the snow as an adjunct to treatment by means of x-rays and radium, and am pleased with the results produced, but, at the same time, I am inclined to sympathise with Thurstan Holland, who, in the discussion on Morton's paper, said, " he wondered whether the effects produced in his own cases had been due to the action of the carbon dioxide snow only."

The treatment of rodent ulcers by means of the snow causes very little pain, except in a few rare instances, whilst it has the additional advantages of bringing about the required reaction more easily, and much more quickly, than any other method of treatment at our command.

Morton recommends that in all cases the granulation tissue should be scraped away until a firm raw surface is left. He then applies a carbon dioxide crayon which has been trimmed to the shape of the ulcer, but a little larger in size, as he considers it advisable to include a small amount of the healthy margin in the reaction. The crayon should be applied with firm pressure for forty seconds. As may be imagined, a lively reaction follows, accompanied with exudation of serum. He recommends that the areas be dressed with boracic acid ointment, and within a week the appearances of an ordinary healthy healing sore should be observed. This skins over rapidly, leaving a soft scar. The first case

Morton so treated required three months for its complete cure.

Morton says :—" I, of course, do not pretend for a moment that I have discovered the ideal treatment for this disease. The facts serve to corroborate my theory that the reaction following the application of solid carbon dioxide should be sufficient to cause the immediate disappearance of a simple uncomplicated case of rodent ulcer. The subsequent healing process was at least as rapid as that following the application of zinc ions, and I firmly believe that the effect will be found to be more far-reaching and complete, as well as less likely to be followed by recurrence. This latter is one of the objections to the ionic method, and is no doubt due to the fact that the ions can penetrate such a very short distance into the tissues.

" In due time we shall know how permanent a cure by this method will be. Personally, I have little doubt as to the result, and that it will be found as reliable as any other method at our disposal. The advantages are very great and obvious ; in simple cases, at least, a very short and nearly painless application, a brief and almost painless reaction, and the place healed up in from ten days to a fortnight. I feel confident that this is a disease where we shall be able to dispense with that very expensive and slow-acting substance, radium; this is very important, as not everybody can afford the time and the money to indulge in this, the greatest luxury of modern medicine."

## CARBON DIOXIDE SNOW IN THE TREATMENT OF LUPUS VULGARIS AND LUPUS ERYTHEMATOSUS.

So far my knowledge of the action of carbon dioxide snow on lupus vulgaris has been principally in its application as an adjunct to the treatment by means of x-rays and radium, and only in very few instances of small isolated patches have I attempted to cure the disease by the use of the snow alone. In these, so far, I must admit, that I have only met with a limited amount of success, perhaps due to an over anxiety to avoid producing a slough.

The snow is useful in sessile, non-inflammatory patches of lupus, which fail to respond to x-ray treatment. In these I have found the application of irritating or stimulating agents of value, prior to the application of the x-rays.

Pusey cautions users of carbon dioxide snow against applying it to areas which have previously been treated with x-rays or radium. In a case of vascular nævus, which had been treated by radium, he found that an application of snow occupying from three to five seconds, produced more reaction than three times the length of exposure brought about in cases not so treated.

Personally I have not noticed such a marked susceptibility as is pointed out by Pusey. I have used snow frequently to clear up the small isolated nodules which remain near the edges of large areas treated by means of the x-rays, with some success. The applications, as a rule, vary from 10 to 20 seconds, and the reaction, as far as I can make out, differs little, if any, from that which follows in cases which have not been previously subjected to the rays.

Stopford Taylor and McKenna have secured excellent results in the treatment of lupus vulgaris, by linear scarification, followed in a day or two by the application of carbon dioxide snow.

Cranston Lowe has watched the results secured in nineteen cases, the majority of which had already been treated with the x-rays, and some of them also with old tuberculin ointment. In a large number of these the areas frozen have shown marked improvement, but in no case can he state that an absolute cure has resulted.

In the treatment of lupus erythematosus I have had no personal experience, but many cases are recorded in which excellent results have followed; indeed some writers consider it the best method of treatment known. There can be no doubt that it brings about a result with great rapidity. It is better used in repeated short exposures than in one long application, and when successful, the resulting scar compares favourably with that which follows any other method of treatment.

## CARBON DIOXIDE SNOW IN THE TREATMENT OF MOLES, WARTS, PAPILLOMATA, ETC.

In the treatment of warts situated upon the scalp, hands, and covered parts of the body, excellent results can be obtained from the application of solid carbon dioxide, granting that the length of exposure given, and the amount of pressure used, is sufficient. The mere freezing of a wart itself has little or no effect, the snow must be applied until a ring of healthy tissue surrounding the growth is perfectly frozen. Applications short of this will only end in disappointment.

In large warts, the thick epithelial growth should be removed by means of a scalpel or other method, prior to the application of the snow. The length of application may in some instances extend into minutes. In corns I have failed, even after a lengthy exposure, to produce satisfactory results.

In soft warts and small moles situated upon the face, solid carbon dioxide, scientifically administered, is a well-nigh perfect method of treatment, and as these in elderly persons can only be retained at some risk, I always advocate their removal as soon as the slightest sign of irritation manifests itself, on account of their tendency to become malignant.

Of the many benign tumours which show a special tendency to become malignant, warts, moles, dermoids, fibromata of the skin, uterine myomata, and papillomata may be specially mentioned. Warts and moles upon the face are so prone to develop epithelioma or rodent ulcer, that under all circumstances they should be removed, preferably by a non-operative method.

In looking through my notes of the large number of cases of rodent ulcer and epithelioma which have passed through my hands during the last twelve years, I find that in a very large percentage there is a history of the disease having started from a pre-existing wart or mole.

Warts and moles upon the face are of necessity irritated to a much greater extent than are similar growths upon the protected portions of the body. This increased irritation is mainly brought about by the rough usage to which the face is submitted during the process of washing and drying, and, in addition, the irritation is kept up by the frequent deposit of dust and dirt upon the growths, whilst they are also exposed to frequent changes of temperature. Growths in this position are still further irritated by the habit of picking and scratching, which is common in persons affected with them. It has been amply proved that the presence of dust and dirt, and uncleanly habits generally, are potent factors in the causation of cancer. I cannot too strongly advocate the removal of such growths, and taking into consideration the fact that cancer frequently follows operation for the removal of benign growths, I would advise that these be removed by one or other of the methods at our disposal which do not entail the use of the knife.

Many elderly persons prefer to retain pre-cancerous growths upon their faces rather than submit themselves to operation.

We have now at our disposal several methods of removing these growths, which entail little more than slight personal discomfort, and there is, therefore, no excuse for retaining a condition which has proved to be an immense source of danger. Amongst these agencies may be mentioned x-rays, radium, carbon dioxide snow and diathermy. It may be argued that malignant growths are quite as likely to appear in the scar-tissue produced by the above-mentioned methods as they are in the scars produced by excision, but inasmuch as, up to the present, this is not proved, and that, therefore, the real objection to having them removed ceases to exist, I have every confidence in recommending these preventative measures.

## CARBON DIOXIDE SNOW IN THE TREATMENT OF DISEASES OF THE EYE.

Carbon dioxide snow has been recommended by Bishop Harman and Reginald Morton in the treatment of trachoma. In its application to this disease the greatest possible care has to be exercised, so that no actual destruction of the tissues is brought about.

The snow is used to produce a well-defined shock to the tissues, with a subsequent brisk reaction.

Although I have no personal knowledge on the use of the snow in this condition, I would suggest the application of the semi-fluid ether-snow (previously described) by means of a brush as being an almost ideal method of treatment. In the treatment of the disease, the duration of each application should be exceedingly brief, and the doses frequently repeated.

In cases of papilloma and rodent ulcer in the region of the eye, a full dose may be administered, the solid stick being used. It must, however, be used with caution, or otherwise the application may be followed by severe œdema into the loose tissues of the eyelids and orbit.

Harman and Morton, whilst not disposed to be over-enthusiastic on the results produced by a limited experience, state :—" That if the effects obtained by the snow only prove to be half as good as those now produced by the use of bluestone, there is a future before it.

Firstly, because it is painless, or nearly so, and, secondly, because it is simple and cheap. In the uses of snow in cases of new growth of the skin; we can speak emphatically; the results are truly phenomenal—indeed, they need to be seen to be believed."

In the treatment of other conditions of the eye and eyelids, the remarks already made as regards the method of application in rodent ulcer, soft warts, papilloma, etc., apply.

When the snow is applied to soft tissues, a certain amount of œdema, nearly always follows the treatment, and special care must be exercised when applying it in the neighbourhood of the eyelids, particularly the lower one, or an alarming amount of œdema, sometimes accompanied by injection of the conjenctiva, may result, causing much inconvenience to the patient. Should this occur to any marked extent, it is well to keep the patient in bed for a day or so, when as a rule the condition will pass off without leaving any ill-result.

It has been stated that contraction of the skin is much less likely to follow treatment by means of carbon dioxide snow than by any other method, and that if great care be exercised, ectropion may be avoided.

## CARBON DIOXIDE SNOW IN THE TREATMENT OF DISEASES OF THE SKIN.

Apart from the special diseases upon which I have written at length, there are many others on my list which can be successfully treated by means of snow. In most of these the snow is used as a stimulating agent, and not to bring about destruction of the tissues. The amount of stimulation required varies from a slight shock to a marked reaction, little short of that necessary to produce necrosis.

Carbon dioxide snow has been used with great success in the keratoses of elderly people. No special rules can be laid down as to the length of exposure necessary; the operator must be guided entirely by the condition, and must apply the snow for such a time as will bring about marked reaction. Cranston Low says that the results are equally good even when the keratoses are undergoing carcinomatous changes, and the cures obtained are permanent. In the keratoses which accompany chronic x-ray dermatitis, as well as the teleangiectases, the use of snow has been advocated and applied with some success. I would, however, warn my readers to only resort to this method of treatment after much consideration, as in the event of a slough being formed, an ulcer may remain which may defy all further treatment.

In the treatment of carbuncles and boils, the snow has proved exceedingly useful. In the early stages of the former much relief may be obtained by ironing over the surface with the compressed tablet, whilst with boils the application of a solid stick, after letting out the small spot of pus in their early stage of development, brings about a speedy resolution, and frequently results in a complete cure.

Destruction of primary syphilitic sores has been advocated; but I entertain great doubts as to the advisability of such treatment, although I can conceive it to be of great use in the treatment of soft sores of the non-infective type. Great care must be exercised in applying snow to the male generative organs, as a large and dangerous amount of œdema is almost certain to ensue.

In erysipelas, ironing the surface of the skin by means of a solid tablet, or applying the ether-snow lightly by means of a brush, allays the inflammation, and cuts short the progress of the disease. Good results have been obtained by the freezing of the dark pigmented patches of skin which appear on the faces and backs of the hands in elderly people. An application of the snow for a period of ten seconds will completely remove the disfigurement without leaving any scar. Freckles may also be treated successfully.

Carbon dioxide snow has been tried in the treatment of sycosis and ringworm. In neither of these, however, can its results be compared with those which are brought about by the application of the x-rays.

There exist many other conditions in which snow may be used either by itself, or as an adjunct to other methods of treatment, and the advisability or otherwise of trying its effects must be left to the discretion of the surgeon, who, having gained by experience a knowledge of its capabilities, is in a position to judge of the possibility of applying it with a successful result.

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